MANAGING PLANET EARTH; Forget Nature. Even Eden Is Engineered. - Correction Appended

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Body

Nearly 70 years ago, a Soviet geochemist, reflecting on his world, made a startling observation: through technology and sheer numbers, he wrote, people were becoming a geological force, shaping the planet's future just as rivers and earthquakes had shaped its past.

Eventually, wrote the scientist, Vladimir I. Vernadsky, global society, guided by science, would soften the human environmental impact, and earth would become a "noosphere," a planet of the mind, "life's domain ruled by reason."

Today, a broad range of scientists say, part of Vernadsky's thinking has already been proved right: people have significantly altered the atmosphere and are the dominant influence on ecosystems and natural selection. The question now, scientists say, is whether the rest of his vision will come to pass. Choices made in the next few years will determine the answer.

Aided by satellites and supercomputers, and mobilized by the evident environmental damage of the last century, humans have a real chance to begin balancing economic development with sustaining earth's ecological webs, said Dr. William C. Clark, a biologist at Harvard who heads an international effort to build a scientific foundation for such a shift.

"We've come through a period of finally understanding the nature and magnitude of humanity's transformation of the earth," Dr. Clark said. "Having realized it, can we become clever enough at a big enough scale to be able to maintain the rates of progress? I think we can."

Some scientists say it is anthropocentric hubris to think people understand the living planet well enough to know how to manage it. But that prospect is attracting more than 100 world leaders and thousands of other participants to the United Nations' World Summit on Sustainable Development, which starts on Monday in Johannesburg.

No matter what they come up with, ice ages, volcanoes and shifting tectonic plates will dwarf human activities in the long run. But communities and countries face concrete choices in the next decade that are likely to determine the quality of human life and the environment well into the 22nd century.

Human activity is such a pervasive influence on the planet's ecological framework that it is no longer possible to separate people and nature.

Emissions of heat-trapping carbon dioxide, whether from an Ohio power plant or a Bangkok taxicab, contribute to global warming.

Seafood lovers dining in Manhattan bistros prompt fishing vessels to sweep Antarctic waters for slow-growing Chilean sea bass. Shoppers in Tokyo seeking inexpensive picture frames send loggers deep into Indonesian forests.

In a new book "Great Transition: The Promise and Lure of the Times Ahead," published by the Stockholm Environment Institute, a group of top geographers, economists, engineers and other experts concludes that the same inventiveness that accelerated the human ascent can be harnessed to soften human impact.

The need for a new approach is urgent, the researchers say, because a surge of growth in quickly industrializing regions of Asia and the Americas could have environmental effects that exceed those of the industrialization of the West. More pressure for change comes from southern Africa and other pockets of extreme poverty where the brutal calculus of Malthus still holds sway.

Even in the industrialized north, after generations of prosperity, people are hemmed in by concrete, seeing commuting times grow and starting to question their definition of progress.

As a result, countless communities, from the charred fringes of the Amazon to the spreading suburbs of Seattle, are balancing growing needs and limited resources.

If development does not change course, the new book concludes, "the nightmare of an impoverished, mean, destructive future looms."

Signs of Improvement

Unexpected Cleanups Generate Optimism

Over the past 30 years, "sustainability" has become the mantra of many private groups, government officials, scientists and, even, a growing number of businesses. Most define the notion as advancing human endeavors without diminishing prospects for future generations. The Johannesburg summit will be the third global conclave in that span chasing this elusive goal.

But movement toward concrete action has been slow. The first meeting, in Stockholm in 1972, rang an alarm about despoiling the earth. Wealthy nations began cleaning air and water, but continued to assault forests and other resources elsewhere to fuel growth.

In 1992 came the second meeting, in Rio de Janeiro, called the Earth Summit. There, diplomats forged ambitious agreements aimed at holding back deserts and protecting the atmosphere, forests and pockets of biological richness.

But the agreements were vague, relying more on good will than on concrete obligations. Developing countries refused to take on obligations, saying the north should step first.

After Rio, population continued to grow, poverty persisted, forests retreated, soils eroded, fish stocks shrank, and concentrations of heat-trapping greenhouse gases rose, despite a treaty in which industrialized countries pledged to "strive" to reduce them.

Now, a host of satellites provides streams of data that powerful computers sift and disseminate on the Web. Communities can track forest loss in Indonesia, sprawl in Indiana and the flow of pollution from state to state, country to country.

After disasters like the chemical release in Bhopal, India, in 1984 and the grounding of the Exxon Valdez in Alaska in 1989, many companies have shifted practices to avoid environmental damage, shareholder wrath and consumer boycotts.

Fast-growing developing countries including China and Mexico are rapidly cutting urban air pollution..

They have been spurred both by commmunity pressure and awareness of the high costs of treating illnesses cause by pollution.

Indonesia, China and other countries are posting factories' chemical emissions on the Web. The technique, pioneered in the United States, is prompting cleanups.

No one expects that people will be able to manage the planet like some giant corporation -- the real Big Blue.

"If you mean making the thousands of little decisions that need to be made, we can no more effectively manage the world than the Soviet Union could manage its centrally planned economy," said Dr. Robert W. Kates, a geographer who headed a National Academy of Sciences committee on sustainable development and is an author of "Great Transition."

But Dr. Kates says the potential exists to make informed choices that spread the benefits of development to an impoverished majority while not depleting vital assets.

One impediment to such a transition is the change itself, the environmental and societal turbulence created by explosive human growth, technological advance and the planetwide linkup of disparate cultures, Dr. Kates and other experts say.

Another barrier, they add, is the enormous growth of population and consumption. Although global population appears headed for a 50 percent increase in the next 50 years, for example, demand for food will likely double, as prosperity raises the per capita consumption of calories.

There is another roadblock. Not every problem of consequence comes with a Bhopal-style wake-up call. Global warming and species extinction are examples of potential catastrophes that are hiding in plain sight, experts say.

Scientists are helping identify problems and opportunities. But communities will make choices guided only in part by what makes sense for the long haul.

For one thing, big gaps persist in the basic information needed to measure progress. When a team from Yale and Columbia studied dozens of trends in 142 countries to rank their sustainability, the members had to leave 40 percent of their spreadsheet blank, said Daniel C. Esty, a Yale law professor, who was a leader of the project.

Nonetheless, optimists say they see signs of hope. Not the least of them is the intensifying dialogue on the problem, which includes parties as disparate as multinational companies and tribal bands.

In essence, the human capacity for understanding the world is catching up with the human capacity to change it, Dr. Clark at Harvard said. "It really is a plausible case that we're coming on a key stage now, with the cold war under control, with globalization happening," he said.

The hard part, he said, will be for societies to overcome a habit of focusing on present needs. "Do we move beyond simply being a big bull in a china shop, having impacts, to becoming a reflective capacity on the planet?" Dr. Clark asked. "Or do we simply bungle ahead?"

An Altered World

Human Imprints From Pole to Pole

Evidence abounds now that the world is a human-dominated place.

By flooding the atmosphere with synthetic chemicals and heat-trapping carbon dioxide and other greenhouse gases, for example, people damaged the protective ozone layer and contributed to a warming climate, scientists have said. The ozone depletion became vividly and unexpectedly evident in the 1980's, when a gaping hole was detected over Antarctica.

The hole will shrink in the next 50 years because of a ban on ozone-eating chlorofluorocarbons. Other damage will not be so easy to repair.

Long before they are cataloged, thousands of plant and animal species are likely to be driven to extinction as forests, wetlands, mountain slopes and other habitats are exploited or harmed by climate change.

Satellites that map vegetation and the nighttime signature of human activity -- fire and light -- show that people have altered more than one-third of the terrestrial landscape. Once it is changed, it is usually changed forever, Dr. G. David Tilman, an ecologist at the University of Minnesota, said. "When you add another 1,000 acres of shopping mall or another highway, far into the future those are probably close to permanent acts," Dr. Tilman said.

Where progress is seen, too often it is only in a slowing rate of destruction, ecologists say. For example, new satellite surveys show that forest loss in the tropics through the 1990's occurred at a rate 23 percent less than previous estimates. But losses still add up to some 14 million acres a year, with 5 million more acres visibly damaged.

The human imprint is evident almost everywhere. In the South Atlantic, fleets illuminate so much of the ocean to attract squid that the illuminated area dwarfs the megalopolis of Sao Paulo. The squid harvest has in part grown because commercial fish stocks have been overfished.

Altogether, scientists have found that two-thirds of commercial marine fish species are fully exploited or diminishing, prompting companies to move down the food chain.

Aquaculture is a fast-growing alternative, but often causes damage like the destruction of coastal mangroves in southern Asia to make way for shrimp farms.

Also, in many cases, farmed species are fed fish meal made of other fish. So the cultivation still indirectly depletes the oceans.

Hydrologists estimate that people appropriate half the world's flowing fresh water. Across the American West in the last 20 years, circular patches made by great rotating irrigation rigs have peppered the land like an expanding checkerboard, marking the draining of aquifers under the plains.

Scientists have concluded that humans not only now dominate the planet, but have also become the dominant driver of natural selection, the machinery of evolution.

The main influence, experts say, is the continuing chemical arms race against germs and pests, which kills most, but leaves a resistant minority behind.

Also, by wittingly and unwittingly moving myriad species around the globe, humans have become a biological blender, carrying West Nile virus to America and overrunning the Bordeaux countryside in France with American bullfrogs that residents say do not even taste good.

Troubling Trends

An S.U.V. Culture Shifts to Third World

Projections for the next two generations do not bode well for easing environmental problems. Even with the population bomb predicted in the 1960's substantially defused, the human population is likely headed for at least nine billion before leveling off.

Most of the growth will be in poor countries, and as people there pursue prosperity, consumption of natural resources will rapidly increase.

Half the world's 17,000 major wildlife refuges are already being heavily used for agriculture, recent studies showed.

Car companies are racing to build factories to assemble sport utility vehicles in India, even as its once-legendary rail system, plagued by mismanagement, is deteriorating and losing freight and passengers, said Dr. Rajendra K. Pachauri, director general of the Tata Energy Research Institute of India. The private organization assesses energy and environmental problems in India.

"In the last 10 years, every major manufacturer has set up facilities in India," Dr. Pachauri said. "They see it as a major market. They have the buzz of the people. This is something that should cause real concern."

Depending on how power is generated, bringing electricity to the two billion people in the world who still lack it could greatly increase emissions of greenhouse gases. But, experts note, the options available to those who remain off the grid also cause harm. The two billion people who cook on wood or dung fires live in acrid clouds of toxic smoke and deplete forests.

In India, Dr. Pachauri said, millions of people light their homes with kerosene, using government-subsidized fuel. Together, cooking fires and sputtering lanterns create indoor pollution that causes asthma and other ailments and that, in India alone, is estimated to kill 600,000 women a year.

Dr. Pachauri's group has experimented with distributing solar-powered lanterns to rural communities. Other projects push cleaner ovens that use less-polluting fuels.

But the question of how to take good ideas from pilot projects to the new norm remains largely unsolved.

Then there are the costs. For example, about a billion people have no clean water. More than twice that number live where raw sewage flows unchecked. So water is a prime focus of the delegates in Johannesburg.

When even countries like the United States lag tens of billions of dollars in improving their sewage systems, experts say the prospects of big investments elsewhere are dim.

New Strategies

Learning to Harvest More From Less

The hardest part of meshing economic and environmental progress, experts say, is that this shift cannot be engineered with top-down directives.

It will be a result of 10,000 decisions, large and small, by countries, communities, companies and individuals, said Dr. Kates, the geographer.

Action will have to be focused where the human imprint is most intense, in forests, on the farm and in the fast-expanding cities, experts say.

An analysis by the World Wildlife Fund found that 20 percent of the existing forest area could provide all the world's future needs for wood and pulp if it was all managed according to environmentally sound practices that a few big companies have already adopted.

Some forestry companies and wood and paper buyers, including Home Depot and Ikea, participate in a program in which wood is certified by the Forest Stewardship Council, a private group. The council monitors forest holdings and products to ensure that wood marketed as environmentally friendly is produced with limited damage.

Other organizations run similar certification programs to encourage growers of other crops like bananas and cocoa to preserve habitat or limit pesticide use.

Those efforts remain a tiny fringe of the markets for those commodities. The Forest Stewardship Council has certified 70 million acres of forests -- just 4 percent of the total acreage controlled by timber companies.

If farming does not change drastically in the next few decades, enormous ecological damage will result, many scientists say.

Dr. Tilman of Minnesota notes that farming has already produced the biggest global imprint of humanity, affecting half the earth's habitable land. The challenge now, he said, will be to double agricultural productivity without using substantially more land.

There are signs this can be achieved. In an extraordinary experiment several years ago, in Yunnan Province, China, rice farmers were recruited to intersperse two varieties on 8,000 acres instead of planting one. The yield nearly doubled, and the occurrence of rice blast, the most harmful disease in the world's biggest crop, fell 94 percent.

Recognizing a good thing, China has expanded the work to 250,000 acres, said Dr. Christopher C. Mundt, a plant pathologist at Oregon State University who helped conduct the research.

"Perhaps more important," he added, "the Chinese are taking the general concept of diversification into related approaches" to other crops.

The key to the next green revolution, Dr. Mundt said, will be abandoning most of the industrial model of agriculture of the 20th century and shifting to a "biological model based on management of ecological processes" like applying fertilizer and water only as needed.

Such efforts are being made in agriculture, forestry, fisheries and other fields around the world. But, once again, experts say the challenge lies in moving to the scales needed to avert widespread harm.

The Role of the City

The Megalopolis As Eco-Strategy

Another focal point for experts who envision a managed earth is cities. In many ways, they are where the battle will be won or lost.

Cities are where almost all remaining population growth will occur, demographers say. The roster of megacities, those with populations exceeding 10 million, is widely expected to climb, from 20 today to 36 by 2015.

These vast metropolises have been widely characterized as a nightmarish element of the new century, sprawling and chaotic and spawning waste and illness.

But increasingly, demographers and other experts say that cities may actually be a critical means of limiting environmental damage. Most significantly, they say, family size drops sharply in urban areas.

"The city is perhaps the most effective device for reducing the birthrate," said Dr. George Bugliarello, chancellor of the Polytechnic University in Brooklyn and an expert on urban trends.

For the poor, access to health care, schools and other basic services is generally greater in the city than in the countryside. Energy is used more efficiently, and drinking and wastewater systems, although lacking now, can be built relatively easily.

And for every person who moves to a city, that is one person fewer chopping firewood or poaching game.

Still, many cities face decisions now that may permanently alter the quality of human lives and the environment.

Dr. Kates said the pivotal nature of these times is perfectly illustrated by Mexico City, which is just behind Tokyo atop the list of megacities. The sprawling megalopolis, where traffic is paralyzed, is about to choose in a referendum between double-decking its downtown highways or expanding its subway system.

One course could encourage sprawl and pollution; the other would conserve energy, experts say.

Chances of Change

'Pernicious Fad'Or Real Prospect?

Some environmentalists say the whole notion of sustainable development is an oxymoron, that the Western industrial model of endless growth, however packaged, cannot possibly persist without grievous environmental damage. At the same time, some business leaders still scoff at the effort.

In a new PricewaterhouseCoopers survey of Fortune 1000 executives' attitudes toward sustainable development, one corporate vice president for environmental affairs called the concept "a pernicious fad."

Some skeptics note that even if cleaner, less destructive industries take hold everywhere, the sheer volume of economic growth could still cause big problems.

But a durable line of pragmatic optimists from science, business and environmental groups, for now, holds center stage.

They say that cleaning the environment and reducing poverty are not only required from an ethical standpoint, but also because they are in humanity's self-interest.

Without improvements, said Nitin Desai, the United Nations official running the Johannesburg meeting, "you create societies that live in a state of perpetual hopelessness."

"That is obviously going to hit back at you at some stage," Mr. Desai said.

Hundreds of businesses, though still a minority, have added sustainability managers to their executive roster.

Prof. Jeffrey D. Sachs, director of the Columbia University Earth Institute, said the world was quickly shifting from a model in which wealth was derived mainly through exploiting resources.

"Most growth now comes from increased knowledge, not from the mining of nature," Professor Sachs said. "And knowledge isn't limited in the way that, say, soil fertility is."

Dr. Kates agrees that economic advancement is vital and says evidence is emerging in many places that it can occur without too much environmental harm. Despite federal inaction on climate change, Dr. Kates said, 129 American cities have programs to cut greenhouse-gas emissions, and California has moved to reduce car emissions.

"This fits with history," he said. "States and cities have always been a major set of social experimenters. This was true on disability insurance and child-labor laws, on antimonopoly laws."

It may well end up being the case that local communities, here and abroad, lead the way in harmonizing people and the planet, he said.

"That ferment," Dr. Kates said, "is the most encouraging sign."

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Correction

An article in Science Times on Tuesday about the impact of humans on global ecosystems misstated the results of an experiment in which farmers in China planted a mixture of two kinds of rice rather than one. (The same error appeared in the section on Aug. 22, 2000, but went unnoticed.) The yield rose 17 percent, nearly doubling for one variety and staying flat for the other; yield did not nearly double for both.

Correction-Date: August 26, 2002

Graphic

Photos: (Greg Whitteman); (Associated Press); (Andrew C. Revkin/The New York Times); (Dr. Janet Earle); (Gibson USA); (Media Hotline)(pg. F1) Chart: "The World Remade By Human Hands"When delegates convene in Johannesburg next week for a United Nations environment summit, they will confront the problems human interference has brought to the world's ecosystems. But some trends once seen as problems may not be so bad after all. And some seemingly beneficial trends have serious unexpected side effects. Here are some examples. MEGACITIESBy 2015, demographers predict, the number of cities with more than 10 million people -- so-called megacities -- will rise to 36, from about 20 today. Megacities are notorious for pollution and sprawling slums. But people who live in them tend to have smaller families and greater opportunities for jobs and educations. And environmental improvements can come quickly to cities. For example, in Mexico City, left, the percentage of days violating pollution standards has fallen to less than 20 percent, from 50 percent. Now the city is considering a mass transit program that would bring further improvements. FOOD SUPPLIESDemographers are lowering their estimates for how much the population of the world will increase before it stabilizes, but even so they predict 50 percent growth by the end of the century. Demand for food will grow even faster, as people in developing countries start consuming more meat and fish. Aquaculture, once thought of as a solution, has produced problems of its own. In Thailand, left, and elsewhere, shrimp farms have replaced valuable mangrove ecosystems. In China, however, a recent experiment in mixing rice varieties in a single field (below) greatly increased yields, without added chemicals. FALLING FORESTSIn the tropics, forests continue to fall before farmers, loggers and timber processors like the saw mill, left, on a branch of the Amazon River in Brazil. But new surveys show that in the 1990's the rate of cutting was 23 percent less than earlier estimates. Some timber companies have gained certification from environmental groups as managing forests with care. Companies that buy their wood, like the Gibson guitar company, promote their products as environmentally friendly. Environmental groups are working with growers of cocoa, bananas, coffee and other commodities to adopt similar programs. And some conservationists now say that judicious logging can actually benefit the plants and animals that live in the forest. (pg. F1) Chart: "U.S. Waste and Recycling" More and More Material, Most of It DiscardedHere are components of municipal solid waste in the United States. Each square equals 1 million tons of waste material. Graph shows RECYCLED and DISCARDED for PACKAGING, NONDURABLE GOODS (Incl. printed matter, disposable plastics, clothing), DURABLE GOODS (Incl. appliances, furniture, tires), YARD WASTE, FOOD SCRAPS, and OTHERS. WHERE IT GOESAlmost a third of waste in the U.S. is recycled: RECYCLED: 30%LANDFILLS: 55%BURNED: 15% 1988: 7,9242000: 1,967 CONSUMER ELECTRONICSTelevisions, stereos, computers, phones and other electronic products are a small but rapidly growing portion of the waste stream: over 2 million tons in 2000 (bold outline). 21% of computers and related equipment is recycled; virtually all TV's, video and audio units are discarded. LEAD accounts for 4% of material in electronic products. Total Waste Per PersonPounds of material annually. This measure peaked in 1999; 2000 material per person fell to 1990 levels due to the slowing economy. Graph shows RECYCLED and DISCARDED figures from 1960-2000. The Growing Waste StreamFive main materials in municipal solid waste. Recycling is not keeping pace with them. PAPERAlmost half is recycled. PLASTICWaste volume is growing fast. Very little of it is recycled. METALSAbout one-third of them are recycled. GLASSIts use has declined because of plastics. WOODOnly about 4% of it is recycled. Graph shows figures from 1960-2000.(Source: Environmental Protection Agency) Exploiting and Protecting LandHumans have altered great swaths of the planet for agriculture and settlements, putting extreme pressure on many ecosystems. Close to a third of the world's land surface has been converted for human use. The United Nations estimates that an additional one-third of lands could be converted in the next 100 years. Far less land is protected from development. Graph shows the: NORTH AMERICAPERCENT OF LAND CONVERTED: 27%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 11.1% EUROPE AND RUSSIAPERCENT OF LAND CONVERTED: 35%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 4.7% ASIA (EXCL. MIDDLE EAST)PERCENT OF LAND CONVERTED: 44%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 6% MIDDLE EAST/NORTH AFRICAPERCENT OF LAND CONVERTED: 12%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 2.1% CENTRAL AMERICA AND CARIBBEANPERCENT OF LAND

CONVERTED: 28%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 6.1% SUB-SAHARAN AFRICAPERCENT OF LAND CONVERTED: 25%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 6% OCEANIAPERCENT OF LAND CONVERTED: 9%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 7.1% SOUTH AMERICAPERCENT OF LAND CONVERTED: 33%PERCENT OF LAND PROTECTED (PARKS, RESERVES, WILDLIFE REFUGES): 7.4%(Source: World Resources Institute) Chart: "The Evolving World Diet"Western diets have long been meat-heavy; now other cultures are starting to catch up. Meat consumption is on the rise around the globe. Fish farming and industrial cattle farming are growing rapidly, bringing more environmental concerns. Graph: "More Meat Consumption" shows the pounds of meat consumed annually per person. Graph: "Growth in Aquaculture . . ."Millions of tons of fish produced. Graph: ". . . And Industrial Farming"Projected percent of cattle and sheep in stalls, pens and feedlots. MIDDLE EAST/NORTH AFRICA1997: 41%2030: 75% ASIA1997: 602030: 60 LATIN AMERICA1997: 152030: 50 SUB-SAHARAN AFRICA1997: 62030: 25 Illustrations (Bill Marsh/The New York Times); (Brett Taylor/The New York Times)(pgs. F4, F5) (Source: Food and Agricultural Organization of the United Nations, World Resources Institute)(pg. F4) Chart: "Look What We've Done . . ."Experts from the World Bank and elsewhere say the availability of environmental information can, in itself, lead to environmental improvements. Satellites are producing a wealth of data. POLLUTION PLUMES OVER AUSTRALIAIn this image, the clouds near Adelaide on the south coast of Australia are color coded to show their density. The light streaks indicate pollution emanating from smokestacks. DEFORESTATION IN RONDNIA, BRAZILBrazil completed the Cuiaba-Porto Velho highway in 1960 but growth in the region was slow until after the World Bank paid to pave the highway in 1980. The region, in northwest Brazil, has since grown to become a substantial farming community. TOKYO SPRAWLInfrared images show the land usage in Tokyo. The red denotes forest, the gray is developed land and the dark blue is Tokyo Bay. THE OZONE HOLEEmissions of chemicals that damage the ozone layer are plunging and scientists believe the thinning, shown here over Antarctica, will reverse itself. GULF SEDIMENTAgricultural runoff and other pollutants flow into the Mississippi River and into the Gulf of Mexico where they nourish phytoplankton, creating, in effect, a dead zone for fish. INDONESIA SMOGWildfires in Indonesia in 1997 left a plume of smoke and smog over Southeast Asia. Researchers are using satellite data to track how different types of pollution move through the atmosphere. LIGHT IN AFRICAUsing a light-sensing satellite, scientists tracked light sources over the course of six months to study land usage. The data will help researchers gauge global change in the environment and population. SQUID FISHINGFishing boats use lights to attract squid. This image shows fishing activity near Japan and Korea. (Sources: NASA; National Oceanic & Atmospheric Administration; U.S. Geological Survey; Daniel Rosenfeld, The Hebrew University of Jerusalem; Michael King, Goddard Space Flight Center; University of Colorado; Colorado State University. Images by Daniel Rosenfield, The Hebrew University of Jerusalem pollution over Australia ; Advanced Spaceborne Thermal Emission and Reflection Radiometer Tokyo sprawl Landsat deforestation in Rondnia, Brazil ; Terra satellite Gulf sediment ; Total Ozone Mapping Spectrometer ozone hole, Indonesia smog ; Defense Meterological Satellite Program lights in Africa, squid fishing) (pg. F5)

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